REMARKS

Claims 1-23 were pending in the Application prior to the amendments herein.

Claims 11-23 are withdrawn from consideration and cancelled without prejudice.

Claims 1-10 are rejected.

Claims 1 and 10 are amended herein. The amendment to claim 10 merely corrects a typographical error. The amendment to claim 1 is supported in the specification at page 4, lines 24-31.

Claims 1-10 are pending after entry of the amendments herein.

1. Restriction Under 35 U.S.C. § 121

The Examiner has restricted Claims into two Groups: Claims 1-10 (Group I), drawn to an electron emitter, and Claims 11-23 (Group II), drawn to a method for making a carbon nanotube electron emitter. Applicant hereby confirms the election, without traverse, of Claims 1-10 belonging to Group I.

2. Rejection Under 35 U.S.C. § 112, ¶ 2

The Examiner has rejected Claim 10 under 35 U.S.C. § 112, second paragraph, as being indefinite.

Applicant has amended Claim 10 to depend from Claim 9 rather than from Claim 10 (itself). Therefore, Applicant respectfully requests that the Examiner withdraw the rejection of Claim 10 under 35 U.S.C. § 112, second paragraph.

3. Rejections Under 35 U.S.C. § 102(b) as Being Anticipated by Jin

The Examiner has rejected Claims 1-10 under 35 U.S.C. § 102(b) as being anticipated by Jin et al., U.S. Patent 6,465,132 ("*Jin*"). Office Action at 4.

Applicant respectfully traverses the rejection.

Anticipation requires each and every element of the claim to be found within the cited prior art reference. Claim 1 requires, *inter alia*, a "carbon nanotube particulate" comprising "entangled small-diameter carbon nanotubes." *Jin* does not teach or suggest a "carbon nanotube particulate," nor does *Jin* teach or suggest a "carbon nanotube particulate" comprising "entangled small-diameter carbon nanotubes." *Jin* teaches "nanowires," which are one-dimensional structures, such as aligned carbon nanotubes, with high aspect ratios, such as shown in *Jin* FIG. 6, item 112, and FIG. 4A, item 28. *Jin* states that carbon nanotubes are

> "Nano-scale wires, such as small-sized carbon nanotubes on the order of 1-100 nanometers in diameter and 0.1-100 μm in length."

(*Jin* at Col. 1, *ll.* 29-32.)

Jin states that carbon nanotubes have one-dimensional electrical behavior.

> Carbon nanotubes exhibit unique atomic arrangements, nano-scale structures, and interesting physical properties such as **one-dimensional** electrical behavior, quantum conductance, and ballistic transport characteristics.

(*Jin*, Col. 1, *ll.* 41-43, emphasis added.)

Also, *Jin* states that carbon nanotubes are one of the smallest dimensional nanowire materials with a generally high aspect ratio.

> **Carbon nanotubes are one of the smallest dimensioned nanowire materials with generally high aspect ratio** and small diameter, e.g., single-wall nanotubes may be made with diameters of ~1 nm and multi-wall nanotubes with diameters of less than ~50 nm.

(*Jin*, Col. 1, *ll.* 49-53, emphasis added.)

In contrast to the one-dimensional "nanowires" taught by *Jin*, the present invention requires a "carbon nanotube particulate" which is a three-dimensional form. Applicant has amended claim 1 to emphasize that the carbon nanotube particulate comprises entangled small-diameter carbon nanotubes **that are arranged in a three-dimensional network.**

As stated above, Claim 1 requires, *inter alia,* that the "carbon nanotube particulate" comprises "entangled small-diameter carbon nanotubes." Not only does *Jin* not teach or suggest a "carbon nanotube particulate," *Jin* does not teach or suggest a "carbon nanotube particulate" comprising "entangled small-diameter carbon nanotubes." In fact, *Jin* teaches away from tangled structures, and, instead teaches "parallel and untangled" nanowires.

> It also would be advantageous to provide nanowires that are aligned in **parallel and untangled** to allow for, among other things, nano-interconnection in an orderly manner without sideway shorting between adjacent contact pads or devices.

(*Jin*, Col. 3, *ll.* 41-45, emphasis added.)

Furthermore, *Jin* teaches the desirability of the nanowires having a "parallel alignment" versus a "tangled spaghetti-like configuration."

> However, for use in making nano-interconnections and field emission devices, desirably the nanowires would i) have a small overall diameter, e.g., on the order of a few nanometers, ii) be capable of existing separately without Van der Waals bundling, and iii) be capable of a parallel alignment along a certain desired direction **instead of having the commonly observed, tangled spaghetti-like configuration.**

(*Jin*, Col. 2, *ll.* 60-67, emphasis added.)

Furthermore, *Jin* teaches the undesirability of and problems associated with "unaligned and tangled nanowires."

> In utilizing the carbon nanowires for circuit nano-interconnections, **unaligned or tangled nanowires can create a risk** of sideway shorting between adjacent contact pads or devices. In field emission devices, unaligned, random distribution of nanowires can cause inefficient electron emissions. In such

> devices, **unaligned nanowires create inefficiencies**, i.e., in the diode field emitter configuration, due to the varying distance and hence varying local electric fields between the cathode (comprised of emitting nanowire tips) and the anode, and in the triode configuration, due to varying distances between the cathode (nanowire tips) and the gate. In addition, when unaligned nanowires are used for emitters in a field emission device, an applied electric field between anode and cathode tends to bend the nanowires toward the field direction, the degree of which is dependent on the applied voltage. This bending causes uncontrollable and undesirable changes in the distance between cathode and gate, and hence alters the local field on different nanowires. In some cases, the bending causes outright electrical shorting between the nanowire tips and the gate. Nanowires pre-aligned in the direction toward the anode could prevent or at least reduce the likelihood of such a bending problem.

(*Jin*, Col. 3, *ll.* 1-23, emphasis added.)

Furthermore, *Jin* teaches the unsuitability of and problems associated with "randomly-oriented or tangled nanowires."

> In the absence of alignment processing, the nanowires tend to grow as randomly-oriented or tangled nanowires. However, **randomly-oriented or tangled nanowires are not suitable** for various applications, such as in making vertical interconnections, as they can cause sideway electrical shorting between adjacent contact pads. For other applications such as field emission devices, tilted nanowires tend to bend or stand up along the field direction which can cause electrical shorting or changes in local fields near the electron emitting tips.

(*Jin*, Col. 3, *ll.* 1-23, emphasis added.)

Furthermore, *Jin* teaches advantages of substantially aligned and parallel nanowires. For example, see *Jin*, Col. 5, *ll.* 41-43: "This invention provides an advantageous method for growing nanowires in a substantially aligned and parallel fashion."

Thus, *Jin* does not teach a "carbon nanotube particulate," that comprises "entangled" carbon nanotubes arranged in a three-dimensional network, as required by Claim 1. Thus, Claim 1 is not anticipated by *Jin*.

With regard to Claim 2, the Examiner contends that "*Jin* discloses the electron emitter of Claim 1 wherein the particulate has a cross-section dimension in the range of about 0.1 micron and about 3 microns." (*Jin* Col. 5, lines 3-6). Office Action at 4.

Applicant respectfully traverses the rejection. With regard to Claim 2, Claim 2 is dependent upon Claim 1 and is not anticipated by *Jin* for the same reasons that Claim 1 is not anticipated by *Jin*. Furthermore, Claim 2 requires that "the particulate has a cross-section dimension in the range of about 0.1 micron and about 3 microns." *Jin* does not teach a "carbon nanotube particulate," let alone a particulate having a cross-sectional dimension in the range of about 0.1 micron to about 3 microns. Instead, *Jin* teaches "small diameter" nanowires. See, for example, *Jin* at Col. 4, *ll.* 59-64.

> With this invention, "small diameter" nanowires, e.g., those having a diameter, on average, of less than 50 nm, and more preferably, of less than 10 nm, may be fabricated. (By "small diameter" herein it is meant that the nanowires individually each have a diameter on the order of about 50 nm or less).

See also *Jin* at Col. 3, *ll.* 52-53.

> The invention embraces a nanowire structure that may be used to fabricate small diameter and aligned nanowires, e.g., having a diameter of less than 50 nm and more preferably, less than 10 nm.

Further, it is apparent in *Jin* that references to "particles" in *Jin* are directed to "catalyst particles," which are separate and distinct from the nanowires of *Jin*.

> To synthesize small diameter carbon nanowires by CVD processing, the catalyst particles should be small, as the size of the catalyst particles will impact upon the final diameter of the nanowires.

(*Jin*, Col. 5, *ll.* 56-60.)

The Examiner referred to column 5, lines 3-6 of *Jin* as teaching a cross-section dimension in the range of about 0.1-3 microns, but no such teaching appears in that paragraph of the reference.

Thus, Claim 2 is not anticipated by *Jin*.

Claims 3-10 are dependent, either directly or indirectly, upon Claim 1 and are not anticipated by *Jin* for the same reasons that Claim 1 is not anticipated by *Jin*.

Therefore, in light of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 1-10 under 35 U.S.C. § 102(b) as being anticipated by *Jin*.

4. Conclusion

Applicant respectfully contends that claims 1-10, as amended and presented herein, are now in condition for allowance.

The Examiner is invited to contact the undersigned attorney at (713) 934-4094 with any questions, comments or suggestions relating to the referenced patent application.

Respectfully submitted,

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February 13, 2006

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